Declaration of Relevant Financial Interests or Relationships

Speaker Name: Xiao Liu

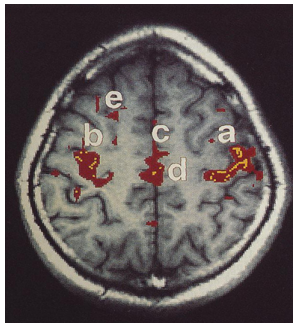
I have no relevant financial interest or relationship to disclose with regard to the subject matter of this presentation.

Spontaneous Co-activation Patterns of the Brain Revealed by Selectively Averaging Resting-State fMRI Volumes

Xiao Liu, Catie Chang, and Jeff H. Duyn

AMRI, LFMI, NINDS, NIH

Non-Stationary fMRI Signal Correlations

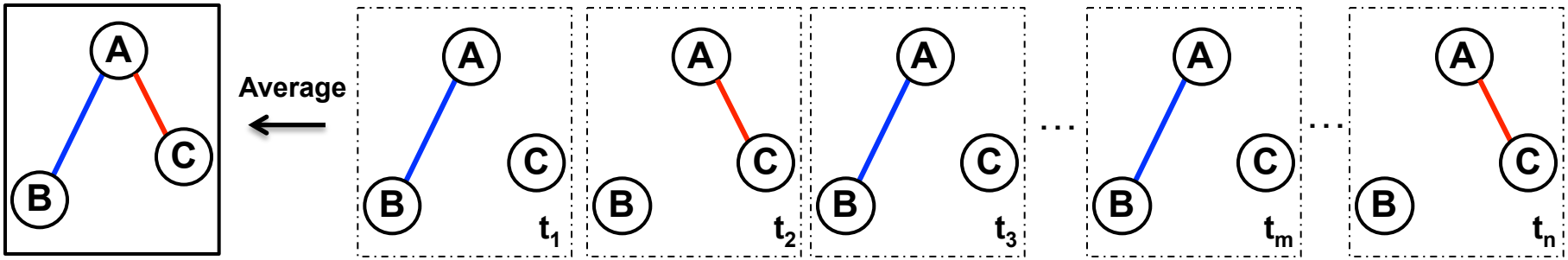


Biswal et al. MRM (1995)

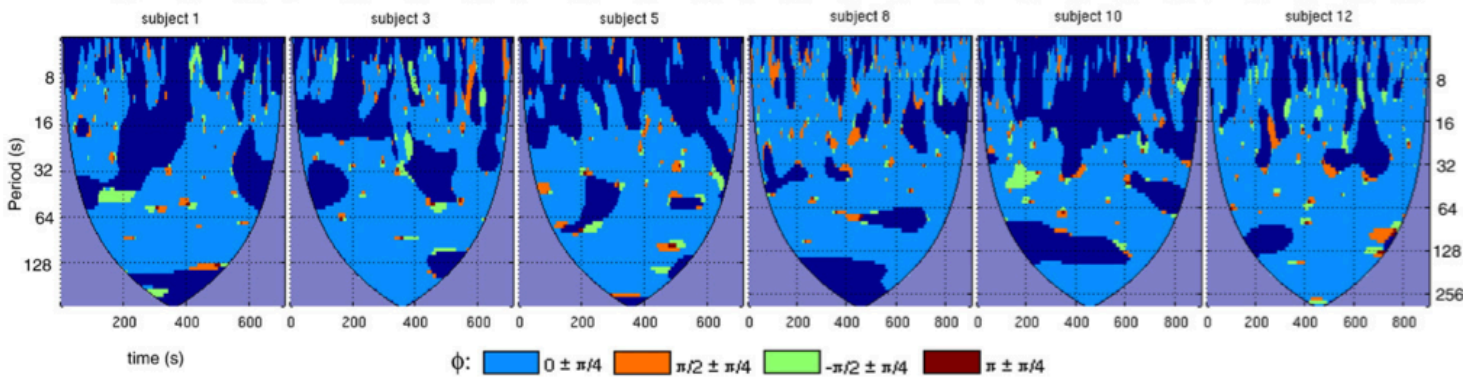
Functional Connectivity

II

Temporal fMRI Signal Correlation (Averaged Relationship)



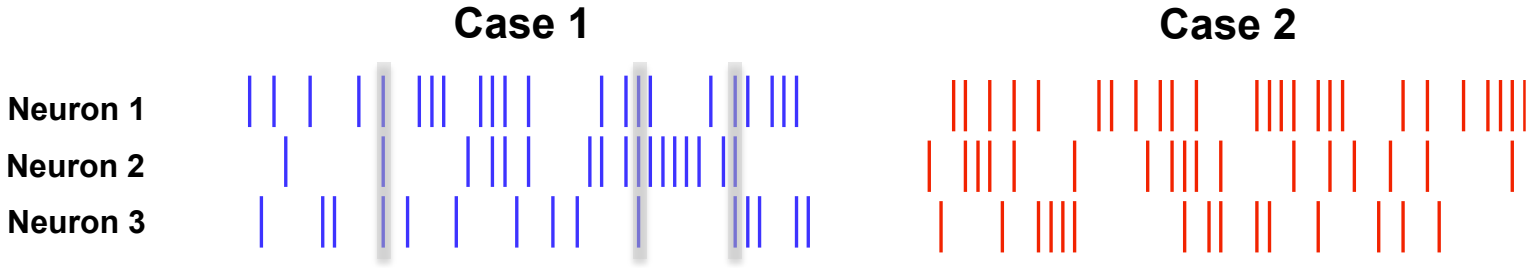
❑ **fMRI correlations vary remarkably over a typical resting scan**



Chang et al. NeuroImage (2010)

Non-Stationary Connectivity: Limitations of Current Methods

- Shorter time window ⇨ Larger temporal variations
  - Solely by the reduction of SNR?
  - Non-neuronal events?
  - Brain connectivity?
- Pairwise correlation
  - High-order correlation: co-activations of multiple regions



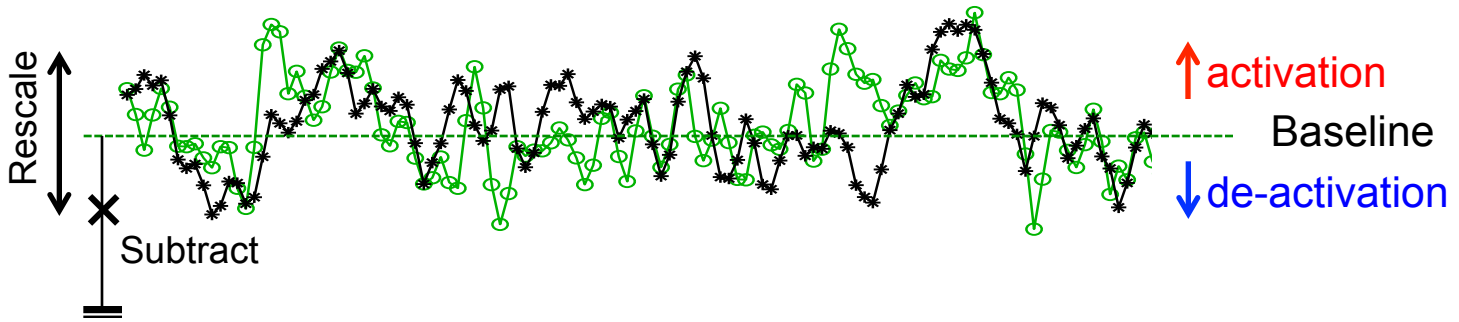
Alternative way to understand non-stationary resting-state functional connectivity?

Dataset and Preprocessing

- Data from fcon1000 project (Biswal, B. B., et al. PNAS 2010)
- Typical pre-processing for resting-state fMRI
  - Motion correction
  - Spatial smoothing and registration
  - Temporal filtering and de-trending
  - Regression with motion parameters and global signals

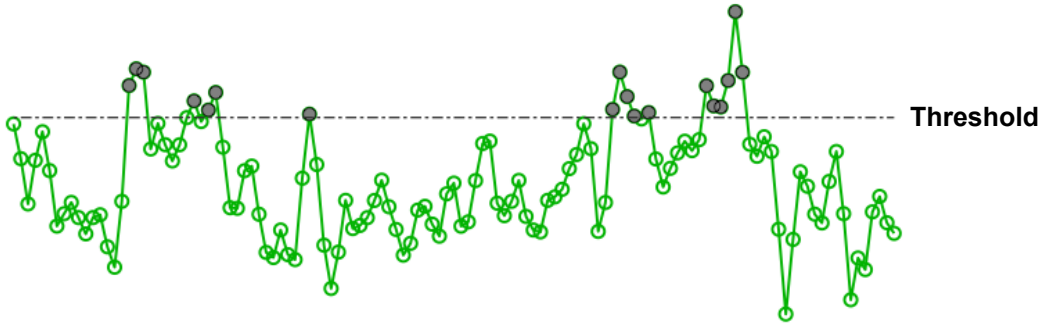
plus normalization

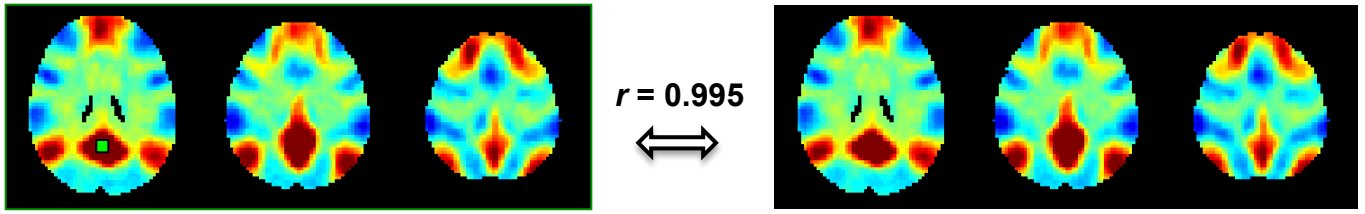
  - Removal of mean
  - Normalized with temporal standard deviation



Replicate RSN Patterns with A Few Time Points

fMRI signal from PCC seed

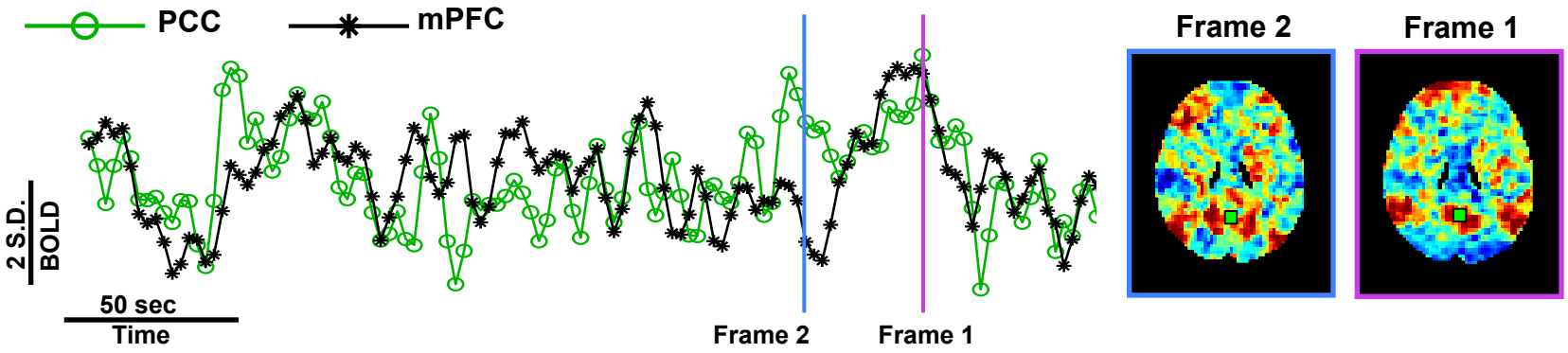




Group CorrMap from 100% data **Average of 15% data**

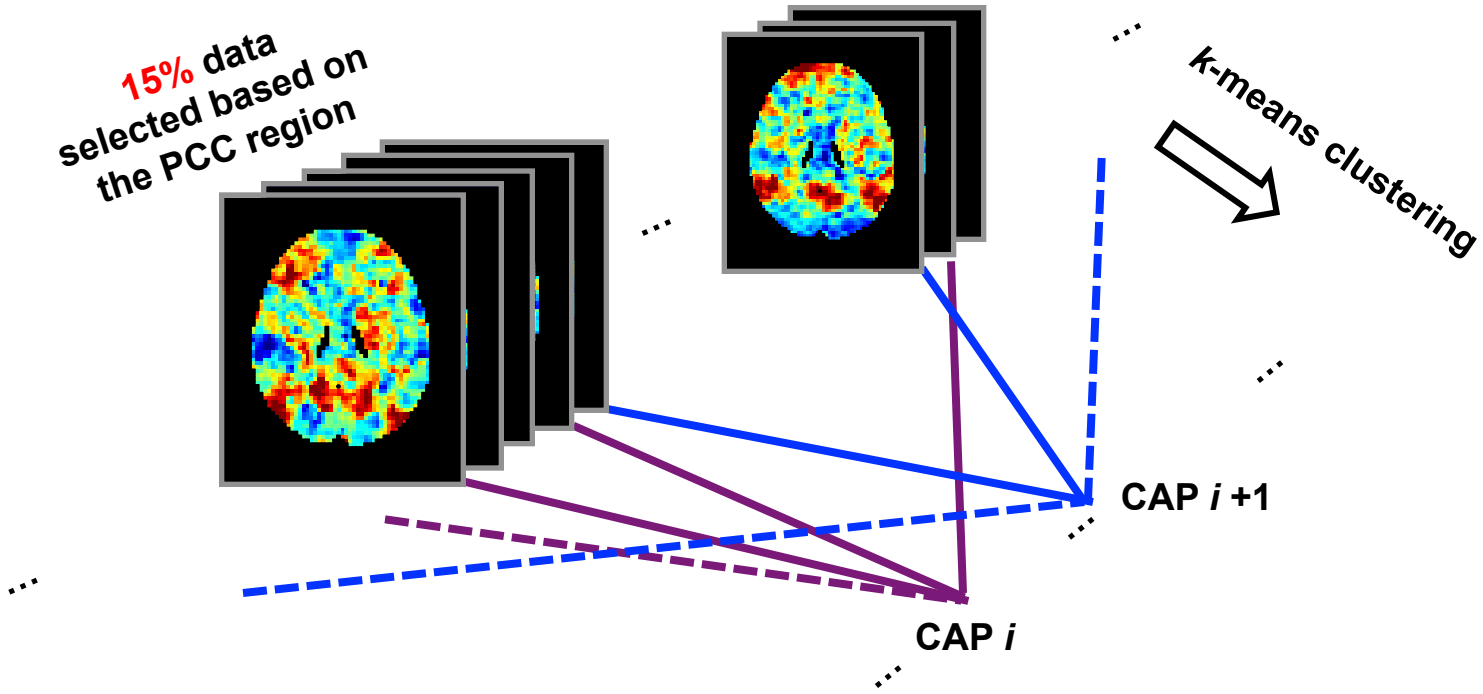
Liu X. and Duyn J.H., PNAS (2013)

fMRI volumes show distinct patterns at different time



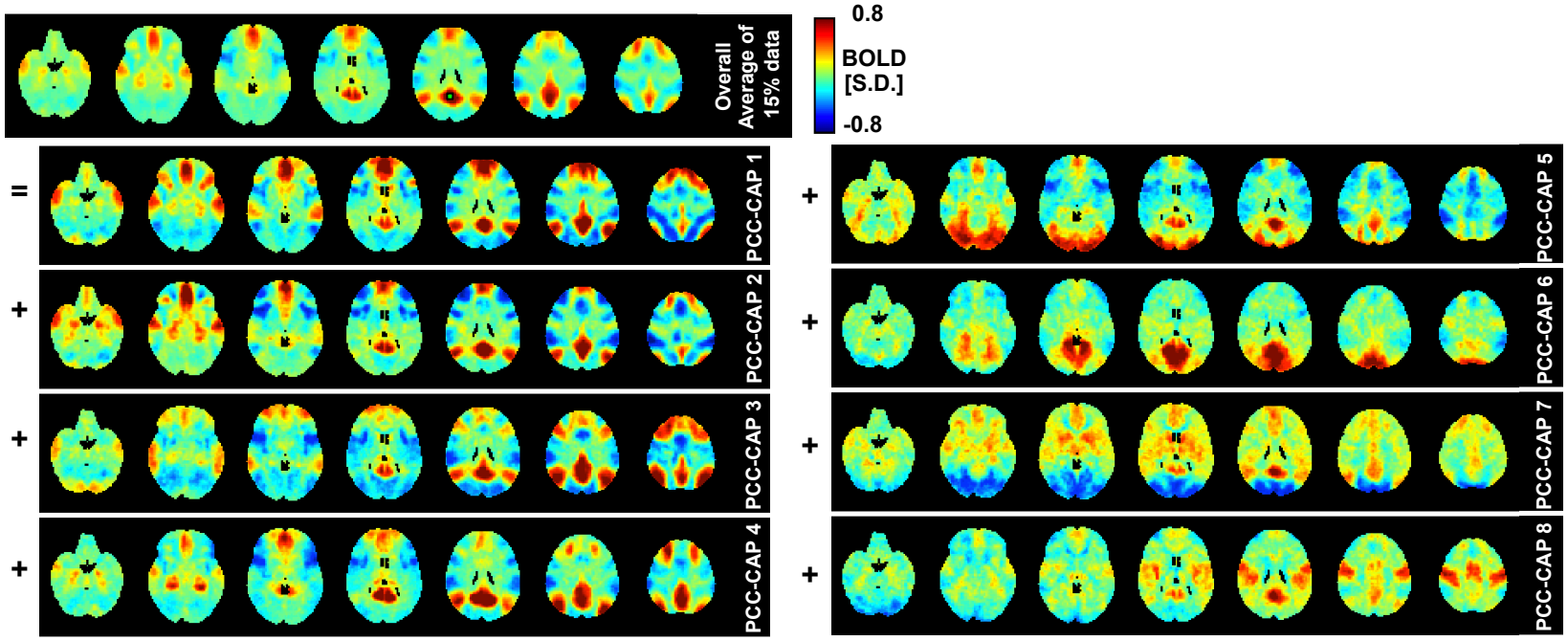
Liu X. and Duyn J.H., PNAS (2013)

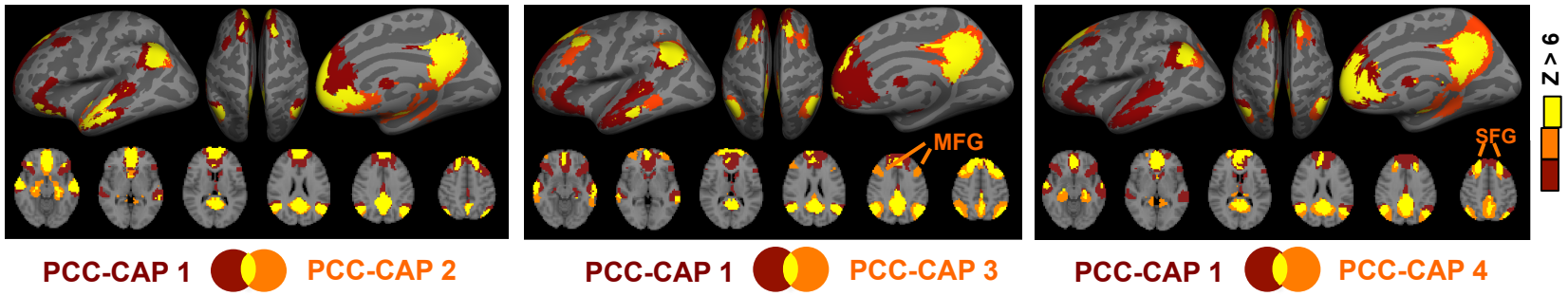
Classifying fMRI Volumes According to Their Spatial Patterns



Liu X. and Duyn J.H., PNAS (2013)

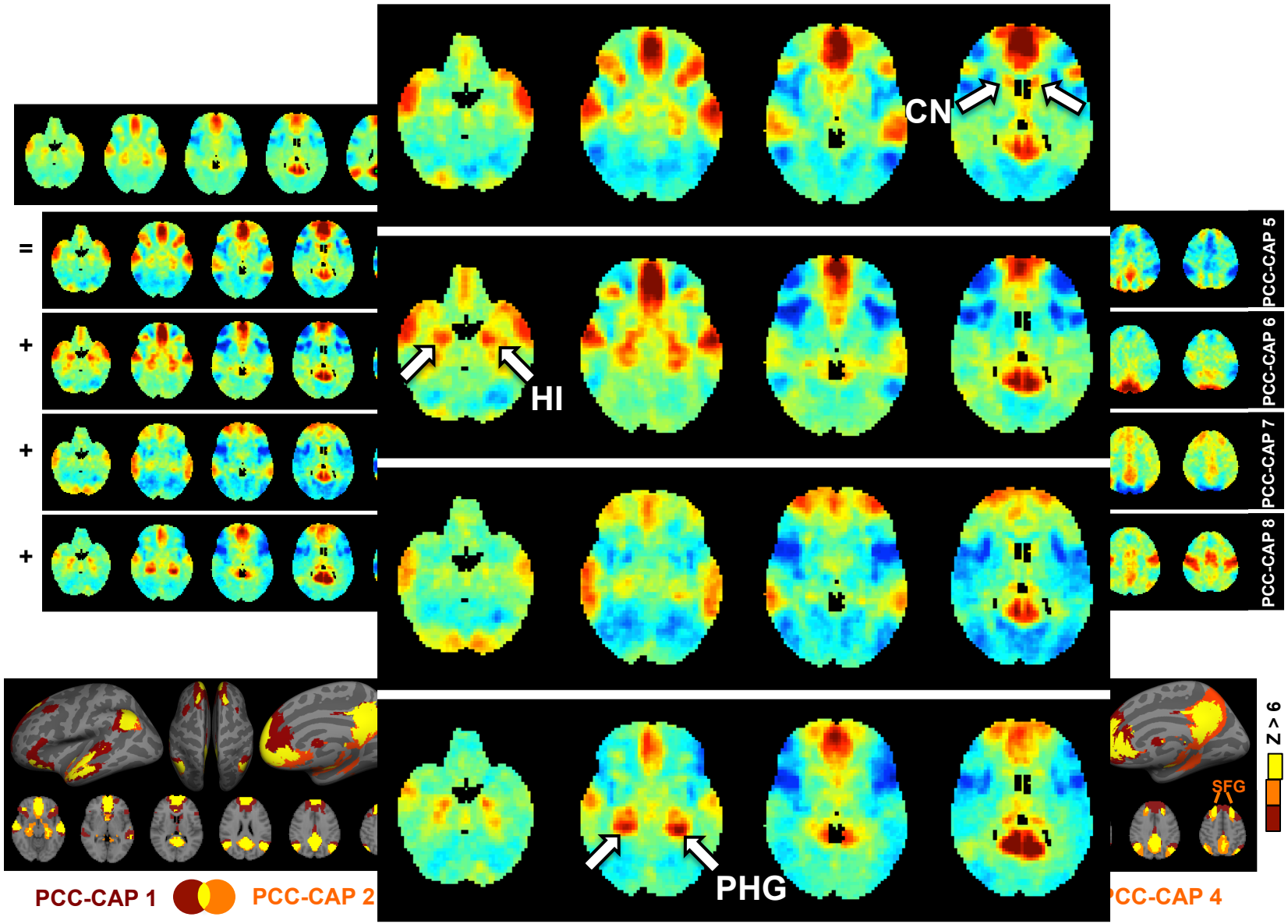
Temporal Decomposition of Default Mode Network





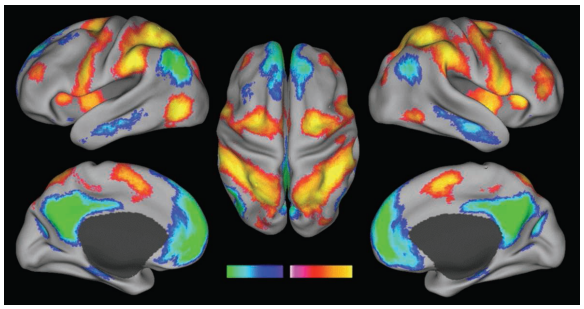
Liu X. and Duyn J.H., PNAS (2013)

Temporal Decomposition of Default Mode Network

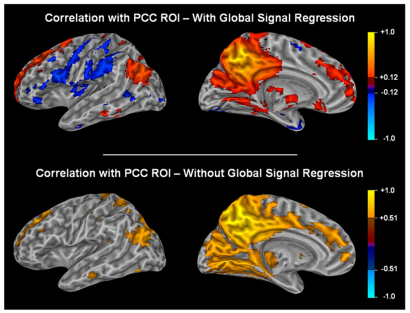


Liu X. and Duyn J.H., PNAS (2013)

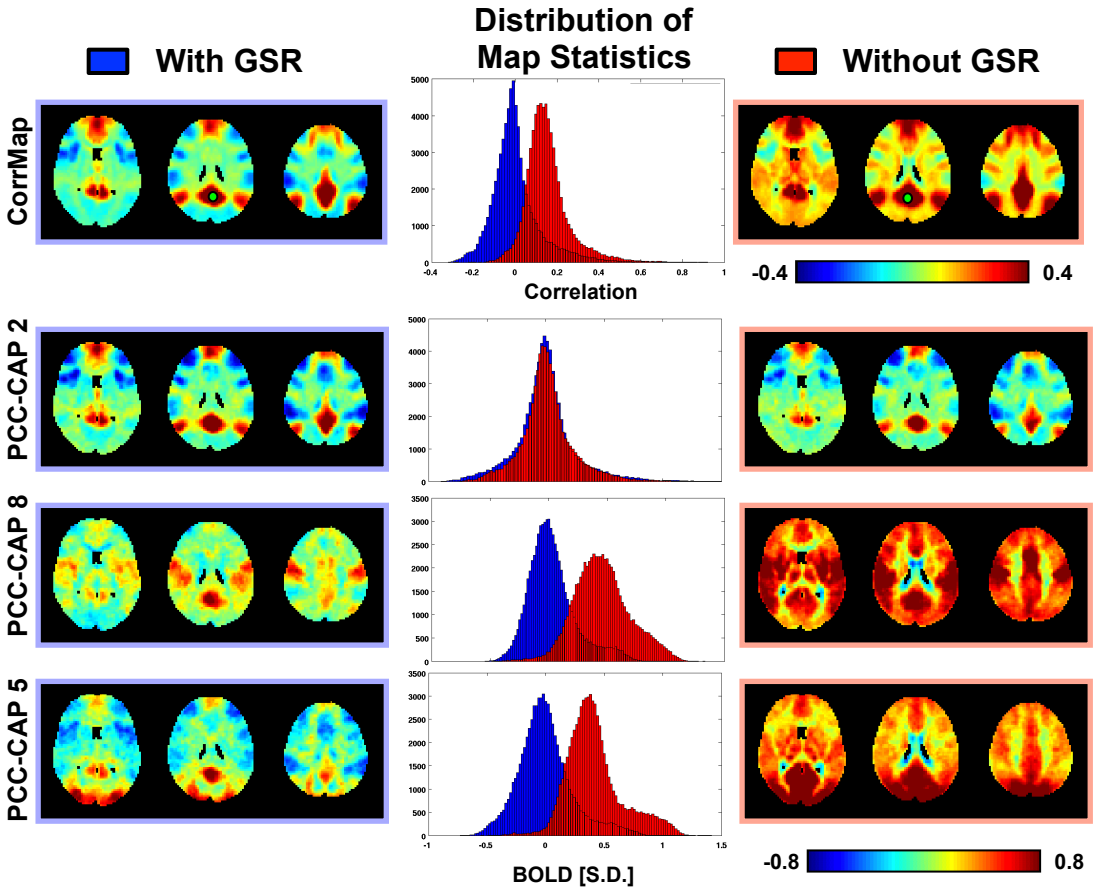
Anti-Correlation and Global Signal Regression



Fox et al. PNAS (2005)

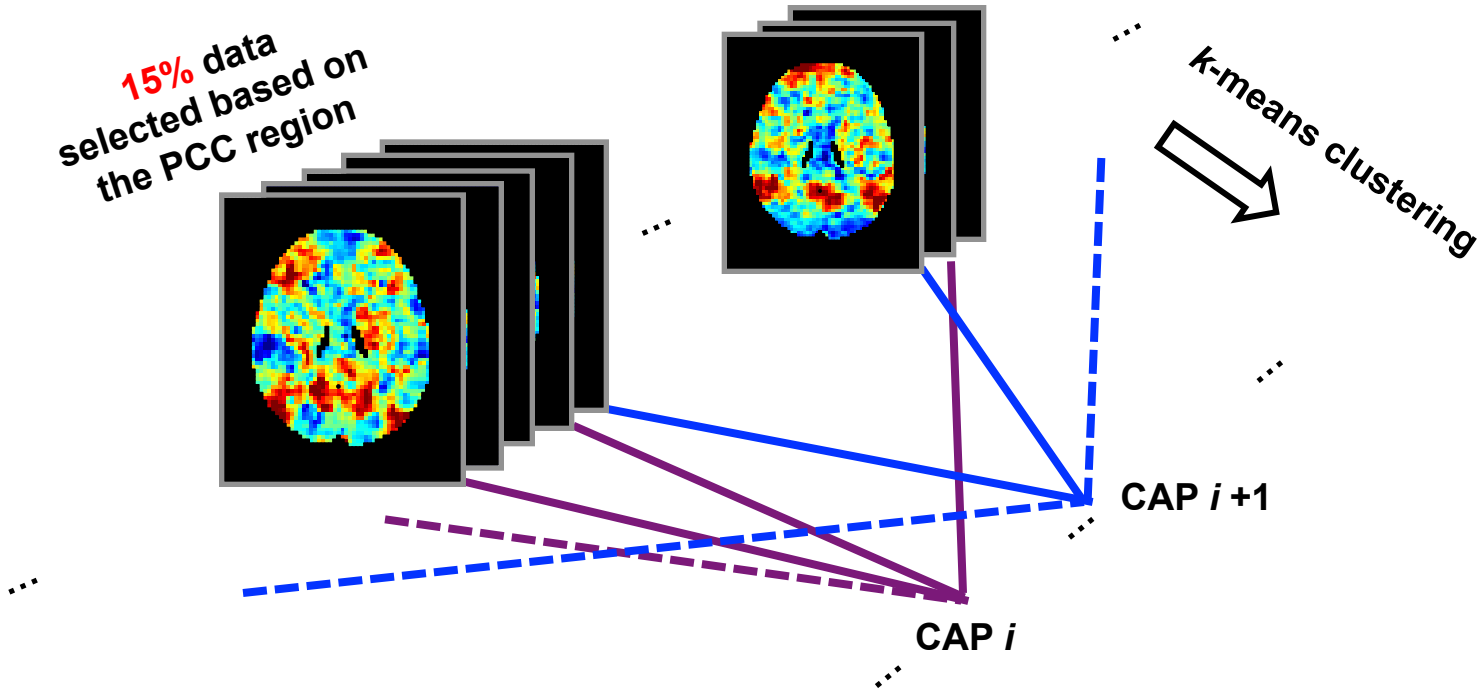


Murphy et al. NeuroImage (2009)

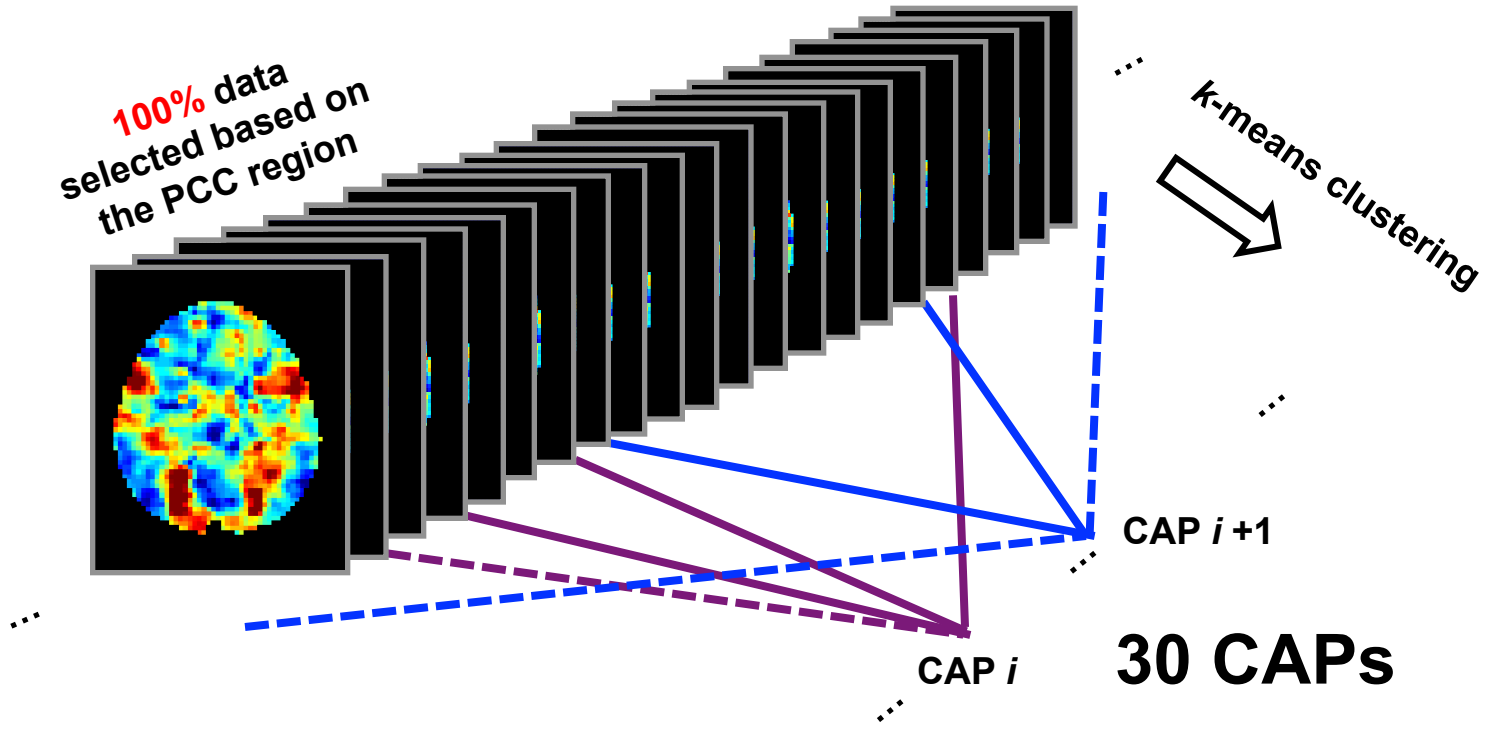


Poster #2251
Thursday
10:30am

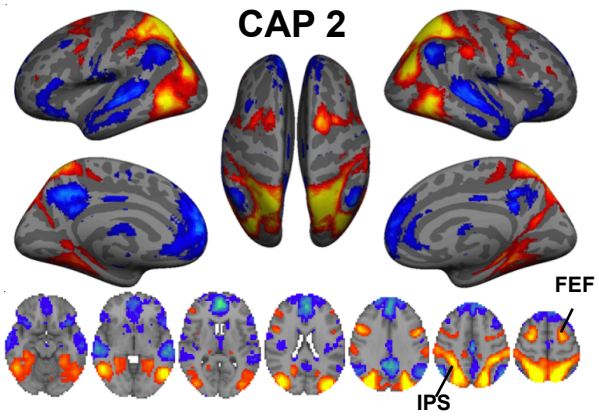
Not Limited By Seeds

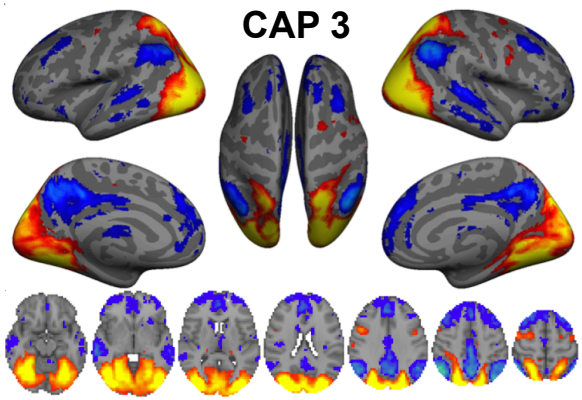


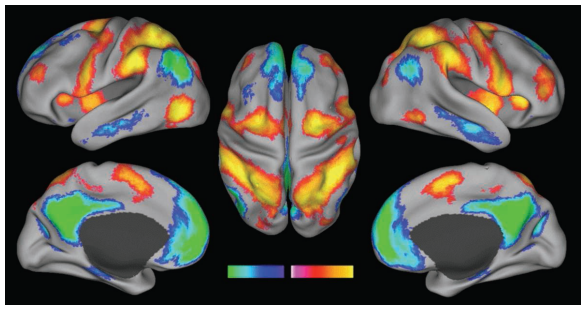
Not Limited By Seeds



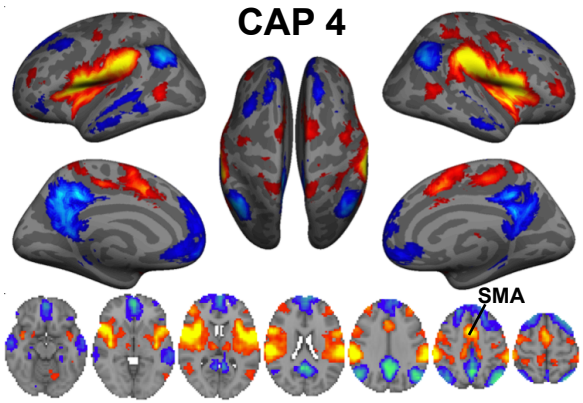
Two Anti-Correlated Networks? Or Multiple versus One?

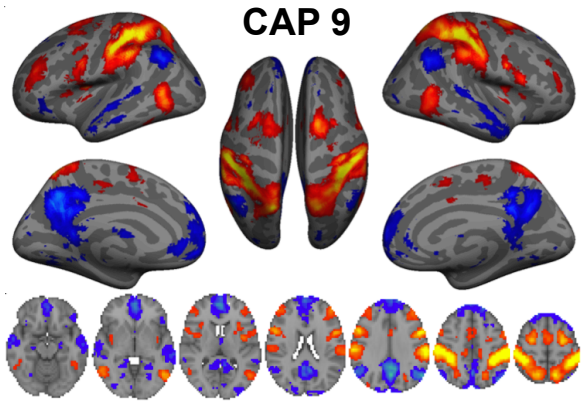


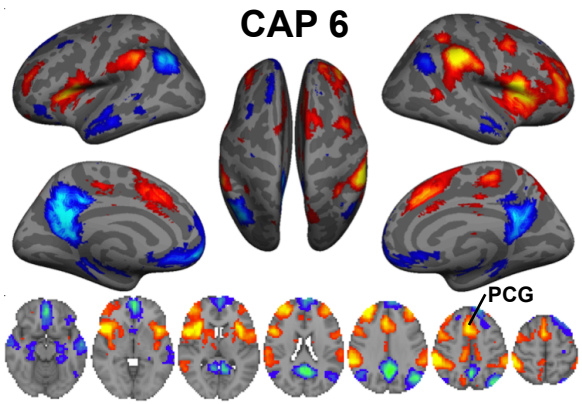




Fox et al. PNAS (2005)

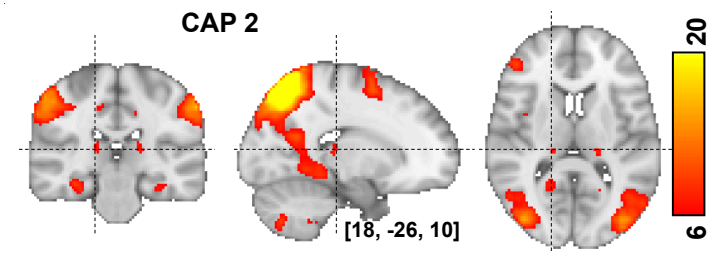


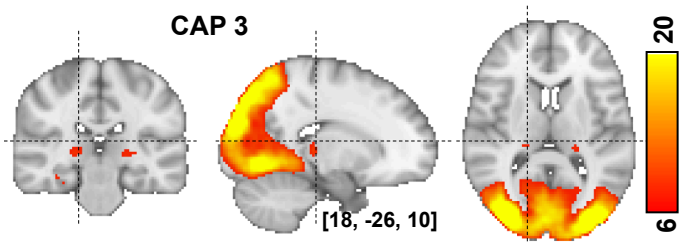


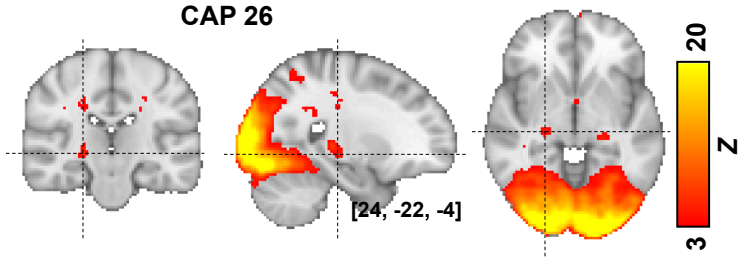


Thalamocortical Co-Activations

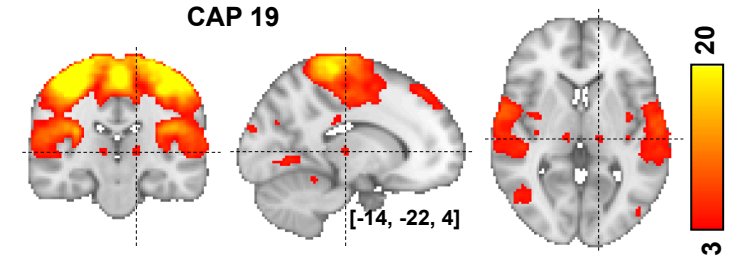
- **Visual**

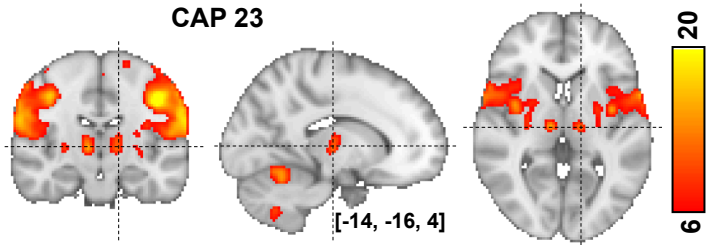






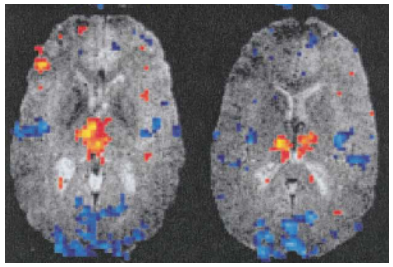
- **Sensorimotor**





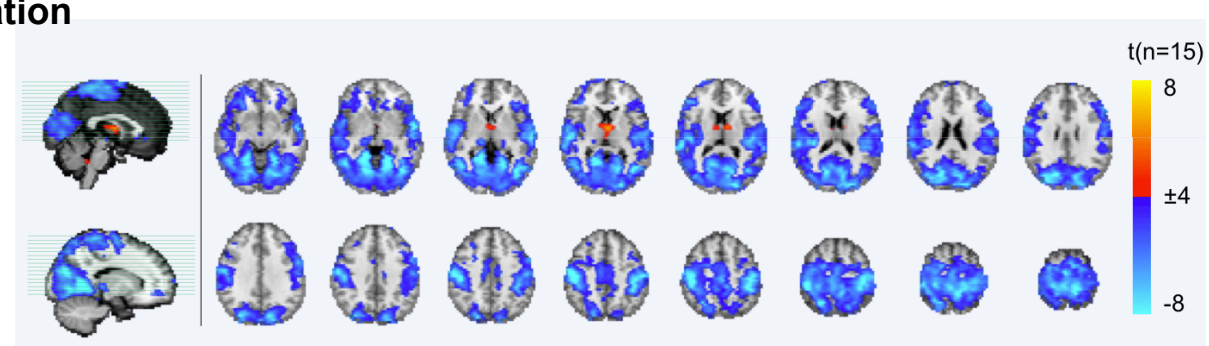
Thalamocortical Co-Activations (Negative)

- **BOLD-EEG alpha power correlation**

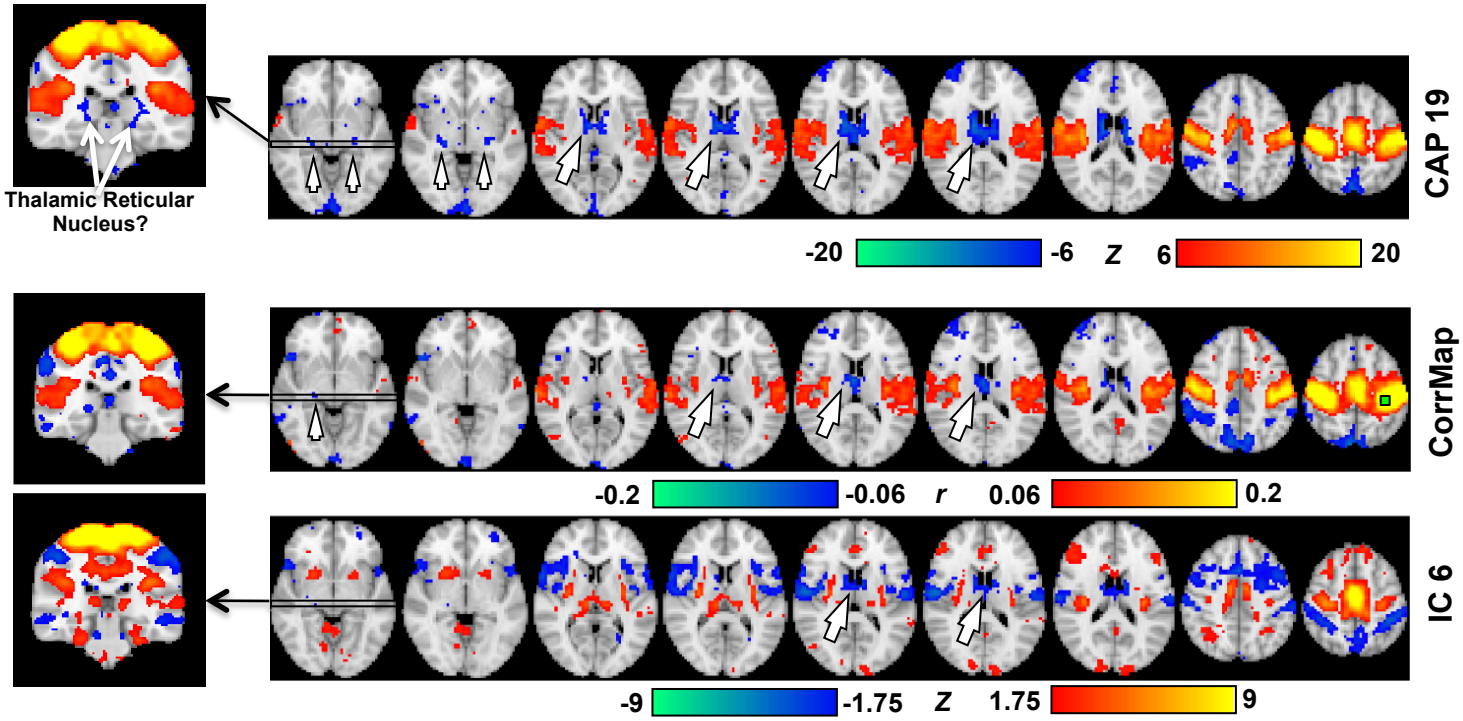


Goldman et al.
Neuroreport (2002)

Feige et al.
J Neurophysiol (2005)

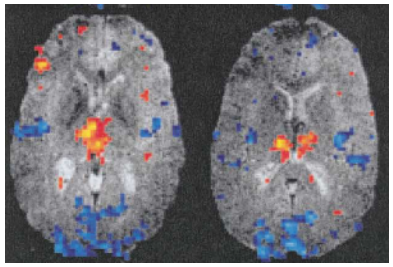


Liu Z et al. NeuroImage (2012)

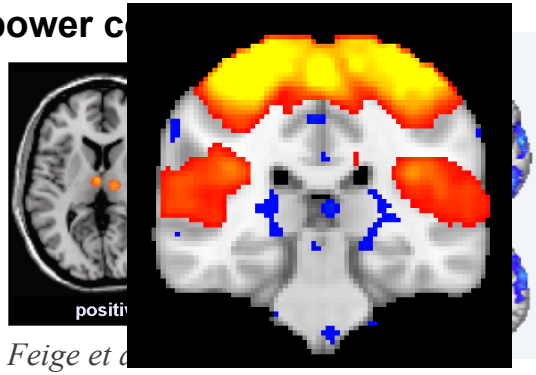


Thalamocortical Co-Activations (Negative)

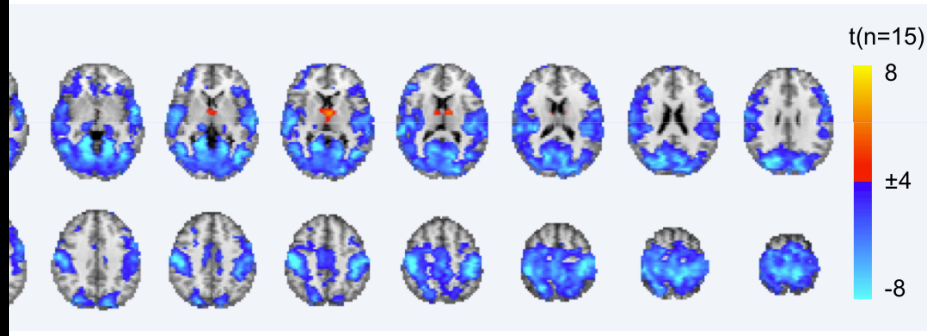
- BOLD-EEG alpha power c



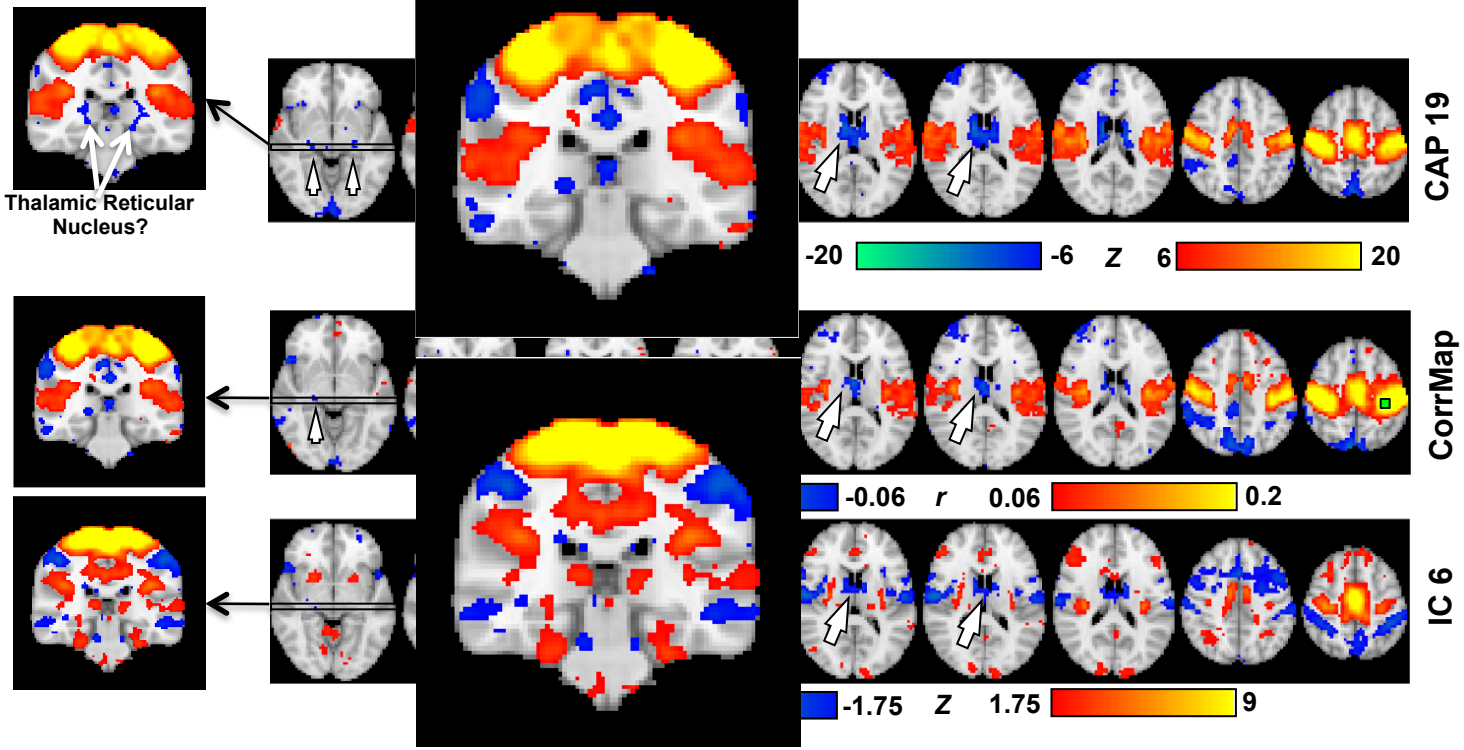
Goldman et al. Neuroreport (2002)



Feige et al. J Neurophysiol (2005)



Liu Z et al. NeuroImage (2012)



Discussions

- CAPs may explain non-stationary functional connectivity
  - Whether the time window includes points with clear patterns (SNR)
  - What types of patterns (neuronal activity)

- A new perspective for resting-state connectivity
  - ✗ Continuous, sustained neuronal interactions
  - ✓ A few co-activation events
  - ? Large-scale neuronal avalanche?(Beggs JM et al., J Neurosci, 2003)

- A new analysis method
  - Data-driven
  - Fewer assumptions and data transformations
  - More specific information regarding co-activation of multiple brain regions

Acknowledgement

Jeff H. Duyn

Catie Chang

Peter van Gelderen

Jacco de Zwart

Duan Qi

Zhongming Liu

Hendrik Mandelkow

Natalia Gudino

Thank You!